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ABSTRACT

This study introduced and demonstrated a new methodology for item and test bias studies: moderated differential item functioning (DIF). This technique expands the DIF methodology to incorporate contextual and sociological variables as moderating effects of the DIF. The study explored differential domain functioning (DDF), so that the focus of interpretation for this test is on the "domain" rather than the item. This moderated DDF effect was shown in a multiple choice and constructed response provincial assessment that was designed to match a specific mathematics curriculum. Participants were 45,728 fourth graders, 45,022 seventh graders, and 43,525 tenth graders in British Columbia, Canada. Data were narrowed to create four contrast groups of communities that reflect differences in contextual variables: rural low-income, rural affluent, urban low-income, and urban affluent. Gender DDF was explored using a general liner statistical model. After statistically matching males and females on their mathematical ability, gender DDF was moderated by the contextual variables. Thus, this "moderation" approach allowed the investigation of sociological, community-based contextual variables that may help explain the complex functioning of DIF in large scale testing. The paper advocates a more "sociological" and "ecological" approach to help explain differences in item and test performance. (Contains 22 references.) (Author/SLD)

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Differential Domain Functioning on the Numeracy Component of the Foundation Skills Assessment: Bringing the Context into Picture by Investigating Sociological / Community Moderated Test and Item Bias

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Abstract

The present study introduces and demonstrates a new methodology for item and test bias studies: "moderated differential item functioning (DIF)". This technique expands the DIF methodology to incorporate contextual and sociological variables as moderating effects of the DIF. Specifically, this paper explores differential domain functioning (DDF) – the focus of interpretation for this test is on the "domain" rather than the item. This moderated DDF effect is demonstrated on a multiple-choice and constructed-response provincial assessment test that was designed to match a specified mathematics curriculum. Participants were 45,728 grade 4 students, 45,022 grade 7 students, and 43,525 grade 10 students in British Columbia, Canada. The data from these participants was narrowed down to create four contrast groups of communities that reflect differences in contextual variables: rural low-income, rural affluent, urban low-income, and urban affluent. Gender DDF was explored using a general linear statistical model. After statistically matching males and females on their mathematical ability, gender DDF was moderated by the contextual variables. Thus, this "moderation" approach allows one to investigate the effect of sociological, community-based contextual variables that may help one understand the complex functioning of DIF in large scale testing. In other words, what we are advocating is to take a more "sociological" and "ecological" approach to help us understand differences in item and test performance.

Differential Domain Functioning on the Numeracy Component of the Foundation Skills Assessment: Bringing the Context into Picture by Investigating Sociological / Community Moderated Test and Item Bias

This paper introduces a new methodology to study the role of contextual variables in differential item functioning (DIF) analyses. DIF is a statistically methodology that is often used in the process of developing new assessment measures, evaluating differential item response patterns of existing measures, and validating test score inferences (Zumbo & Hubley, 2003). Typically, DIF is explored by using gender or ethnic grouping variables. In addition, a few DIF studies have explored cognitive factors to help understand when and why DIF occurs. Furthermore, no DIF method, to our knowledge, has explicitly incorporated moderator effects of contextual sociological / community variables to help understand when, why, and to what degree DIF may occur. In a DIF framework, moderator effects would occur if a moderator variable (e.g., socioeconomic status) influences the *direction* or *magnitude* of DIF. In other words, the DIF depends on some other contextual factor(s).

Moderated DIF

Given that moderated DIF will be explored using a statistical modeling approach, we will describe it within the context of an example using regression DIF methodology. In a typical regression DIF analysis one models each item as:

$$Y = b_0 + b_1\text{TOT} + b_2\text{GRP} + b_3\text{TOT*GRP}, \quad (1)$$

where TOT denotes the conditioning variable, GRP the grouping variable(s), and TOT*GRP the interaction term of the grouping effects variable and the matching variable.

The moderated DIF would be an extension of the above stated model wherein the gender DIF effect (i.e., the direction and/or magnitude of DIF) depends on the level of a third variable (i.e., the moderating variable), such as the income group of the examinees. In this sense, the DIF effect is moderated by level of income. Finally, given that family income can be considered a contextual (or systemic) variable, the DIF effect would be moderated by a contextual variable. That is, DIF not only depends on the grouping variable (e.g., gender), but the presence or absence of DIF is moderated by another variable, such as family income.

One can expand equation (1) to incorporate the moderating variables:

$$\begin{aligned} Y = b_0 + b_1\text{TOT} + b_2\text{GRP} + b_3\text{TOT*GRP} \\ + b_4\text{INCOME} \\ + b_5\text{TOT*INCOME} \\ + b_6\text{GRP*INCOME} \\ + b_7\text{TOT*GRP*INCOME}, \end{aligned} \quad (2)$$

where the notation is the same except for INCOME which denotes the moderating variable, in this case, income level.

Just as typical DIF modeling has a natural hierarchy of entering variables into the model, wherein the sequence is first the conditioning or matching variable, second the main effect and third the interaction terms, moderated DIF modeling also has a natural hierarchy. That is, the expanded statistical model includes the following variables in sequence: (i) the conditioning or matching variable (i.e., total scale score), (ii) the main effect DIF grouping variable (e.g., gender), (iii) the interaction between the conditioning variable and DIF grouping variable, (iv) the main effect moderating variable (i.e., contextual variable), (v) the interaction between the

conditioning variable and moderating variable, (vi) the interaction between the DIF grouping variable and moderating variable, and finally, (vii) the three-way interaction between the conditioning variable, DIF grouping variable and moderating variable. In short, the number of explanatory variables in the DIF regression model is increased with an eye toward a better understanding of the sociological process of gender differences. Given the contextual nature of this variable it may be at the individual or community level. For the described model above, the regression variable (ii) is the uniform DIF, (iii) is the non-uniform DIF, (vi) is the moderated uniform DIF effect, and (vii) is the moderated non-uniform DIF effect. If a moderated DIF effect is found, post-hoc analyses could be used to investigate at which levels of the moderating variable the DIF effect is present.

Numerous theories in the social sciences postulate the existence of moderated relationships. We would argue that moderator variables are also relevant in the area of assessment. For example, standardized assessments must be fair so that examinees with equal ability levels have an equal probability of correctly answering each task. In general, equality among examinees is commonly investigated in relation to gender and ethnicity; however, equality among examines also implies comparisons among other contextual factors such as those at the community level (e.g., rural versus urban locations), as well as those at the individual-level (e.g., parental education). Thus, moderated DIF methodology allows one to take into account theoretical relationships among contextual variables.

This paper will shine a light on the notion of using socio-cultural variables as explanatory variables in DIF and particularly as moderating variables. The moderated DIF methodology will be introduced in the context of a case study. Note that the case study is particularly unique because it exploits the availability of linked data to address the matter of contextual variables.

Case Study

Moderated DIF will be demonstrated in the case of numeracy from a standardized assessment. The numeracy component was chosen because of the heightened awareness from educators and policymakers that mathematics education has an important role in our technological world, and is thus often called the "critical filter" for success (Frempong, & Willms, 1999). Although gender differences in mathematics performance are decreasing over time and the average gender difference in mathematics performance is small (Friedman, 1994; Frost, Hyde, & Fennema, 1994; Hyde, Fennema, & Lamon, 1990), gender differences on tests involving numeracy continue to be of major concern to educational researchers (e.g., Friedman, 1994; Leder, 1992; Ryan & Fan, 1996; Tate, 1997).

To accurately interpret gender differences in performance assessments DIF is essential because it aids us in ruling out item and test bias an explanations for the observed gender differences in test performance. Likewise, fairness among examinees is important because standardized achievement tests for elementary and secondary school students are commonly used to (1) provide information on student learning in selected areas of the curriculum in relation to national standards, (2) assist in curriculum and program development, and (3) to aid policy–makers and school administrators in decision-making. Standardized achievement tests are also useful for identifying subpopulations of students who require additional help and support. More recently, these tests are also being used as part of an educational accountability system that assesses teacher, school, and district performance (Raham, 1998; British Columbia Ministry of Finance and Corporate Relations, 1996). As previously mentioned, fairness among examinees implies fairness among *all* possible subgroups of examines including examinees from different

ethnic groups, SES groups, and those who live in different neighborhoods (e.g., rural and urban).

A number of recent studies focusing on gender-related DIF in mathematics assessment have identified item characteristics such as item format, and item content which may influence students' performance on mathematics tests (Garner & Englehard, 1999; Harris & Carlton, 1993; Lane, Wang, & Magone, 1996; O'Neil & McPeek, 1993; Ryan & Chiu, 2001; Ryan & Fan, 1996; Scheuneman & Grima, 1997). However, the interaction of gender DIF and sociological / community moderating variables has not been investigated. Although different contextual variables such as classroom size (Ehrenberg, Brewer, Gamoran, & Willms, 2001), socio-economic status (SES) (Chao & Willms, 2000; Frempong & Willms, 1999), teaching practices (McCaffrey et al., 2001), and parental styles (Chao & Willms, 2000) have been explored in relation to school achievement, such variables have not been investigated as moderating variables in DIF analyses or even item or test bias.

Participants

The participants in this study consisted of 45,728 grade four students, 45,022 grade seven students, and 43,525 grade ten students in British Columbia who wrote the Foundation Skills Assessment (FSA) examination in the spring of 2000 and whose school level information matched the 1996 Stats Canada census survey. The matching of school-level census attributes to FSA data was important as it allowed the school code to be subsequently matched to student level FSA data. The major assumption of the methodology is that for a given set of students in a school with the same postal code, the aggregate value of the census characteristic is equal to that of the community in the area with the postal code. However, due to time differences between reporting periods (i.e., 1996 census data and 2000 FSA data) demographic characteristics for some students who wrote the FSA were unavailable. In those cases, the missing census data was the result of schools that did not exist in 1996 and were opened in a following year. Efforts were made to update the census data to more current school codes, but there were still some school codes that did not return census attributes. In these cases, the missing census data was the result of school postal codes being incorrect or not available at the time the census data was compiled (1999). In total, 867 students in grade four who wrote the FSA were eliminated from the data extraction because their student records could not be matched to census data. As a result, the total number of grade four students included in the data extraction was 47,014, of which 1286 had missing values for some of the contextual variables (i.e., family income <30K; rural versus urban) investigated in this study, and a total of 45,728 cases were therefore used for the analyses of grade four students. Similarly, 1,419 grade seven students' records and 2324 grade ten students' records could not be matched to the census data. The sample sizes for each grade level, by gender and age, are provided in Table 1.

Table 1. Number of students for each grade, by gender and age.

Grade	N	Male (n)	Female (n)	Age		
				Mean (Std. Deviation)	Min.	Max.
4	45,728	23,019	22,709	9.72 (0.47)	9	11
7	45,022	22,911	22,111	12.72 (0.49)	12	14
10	43,525	22,302	21,223	15.76 (.55)	15	18

The Foundation Skills Assessment

Moderated gender DIF will be demonstrated using students' responses on the numeracy component of a provincial examination called the Foundation Skills Assessment (FSA). The numeracy component was designed to measure critical thinking skills in mathematics that are embedded in the British Columbia education curricula for students in grades four, seven, and ten. The main purpose of the FSA was to help the province, individual schools, and districts evaluate how well important foundation skill areas are being addressed in order to make plans for improvement. It is because of this main purpose that the matter of moderated gender DIF by contextual (sociological) variables is so important.

The numeracy component consists of 32 multiple choice items and four constructed response items that were designed to measure four major content domains: number, patterns and relations, shape and space, and statistics and probability (see Appendix 1 for the table of specifications for the FSA). Inferences and comparisons are typically made based on these four domains. In addition to examinees item-by-item test information from the 2000 assessment year, their individual and school-level information is statistically linked with the 1996 Statistics Canada census data so that contextual variables at both school and individual levels can be investigated.

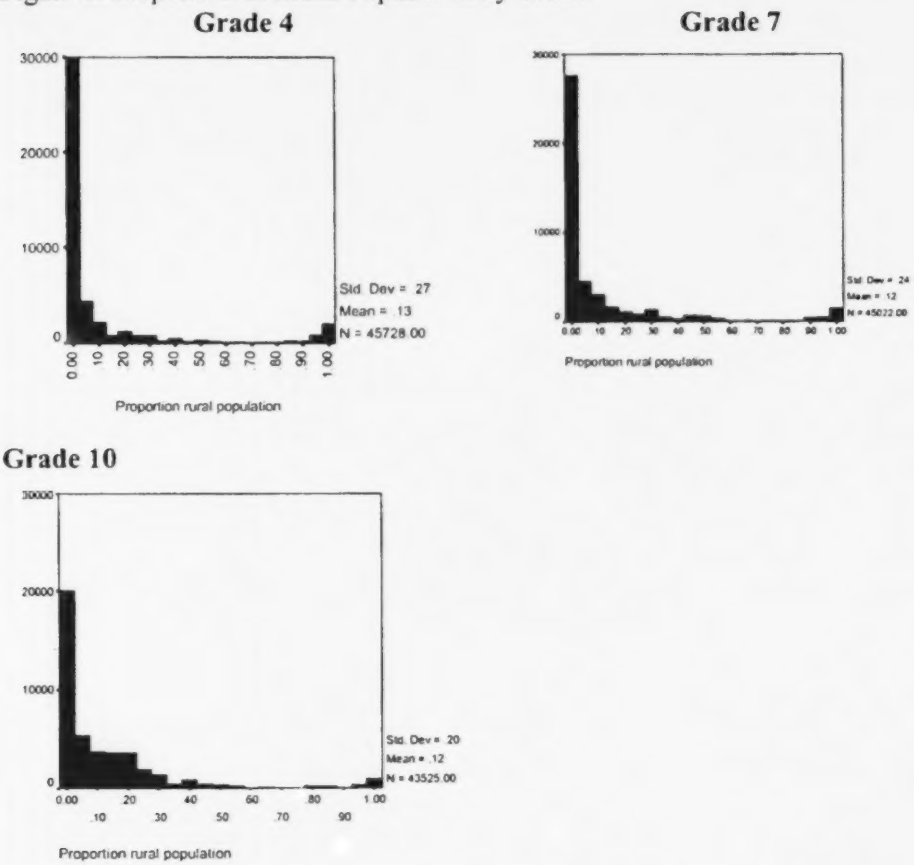
Moderator variables for the case study

Moderated DIF explores external explanations (rather than solely internal cognitive explanations) for the potential item or test bias. Because of the wide use of rural versus urban community and average family income as explanatory variables in the sociology of education literature, these variables are our moderator variables to introduce moderated DIF/DDF.

Rural versus Urban contextual variable

The rural versus urban community is defined as the proportion of families who live in a rural location. The definition of rural is based on the Statistics Canada 1996 Census definition of rural as "sparsely populated lands lying outside urban areas" or in other words those areas with a population concentration of less than 1,000 and a population density of up to 400 per square kilometer (Statistics Canada, 2001a). Moreover, "community" in this study is the school community, and therefore, those students who attend the same school are designated as living in the same community. To create rural versus urban contrast groups, those students who attended schools in which the school community was designated as having 0% of families living in a rural area, were assigned as "urban." In contrast, those students who attended schools in which the school community was designated as having 50% or more of families living in a rural area were assigned as "rural." Because of these divisions, many cases were omitted from analyses because they were not clearly in an urban or rural community (see Figure 1).

Figure 1. Proportion of Rural Population by Grade



Family income contextual variable

The second contextual variable is the family income level. There were two family income variables used in this study: the proportion of families whose income is (1) less than $20,000 per year, and (2) less than $30,000 per year. Canada's low-income thresholds are based on the size of households and size of community. Thus, large urban communities have higher income thresholds because of the higher cost of living, particularly housing costs (First Call, 2002). As cited in the latter reference and based on Statistics Canada data (Statistics Canada, 2001b) a three-person family living in an urban community with gross yearly income of $30,000 would be counted as living with a low income. That same family living in a rural community would not be counted as living with a low income. Rather, a three-person family living in a rural community with a gross yearly income of $20,000 would be counted as living with a low income. Therefore, in order to create appropriate income contrast groups, the rural or urban community location as

described above was taken into account. For those students' who lived in a rural community, we used the family income variable less than $20,000, and for those students who lived in an urban community we used the family income variable less than $30,000. For each situation, we designated affluent versus low-income families to be in either the 10th percentile or less and the 90th percentile and above, respectively. Cases where the income level was between the 10th and 90th percentile were omitted from analyses because they did not fit within our contrast group definition. See Table 2 for the community location by income level breakdown for each grade.

Table 2. Cross Tabulation of contrast groups for each grade by gender

Grade	Contrast Group		Female	Male	Total
4 (N=4559)	Rural	Low-income	193	233	426
		Affluent	221	215	436
	Urban	Low-income	930	890	1820
		Affluent	917	960	1877
7 (N=4142)	Rural	Low-income	163	166	329
		Affluent	163	163	326
	Urban	Low-income	848	857	1705
		Affluent	874	908	1782
10 (N= 2577)	Rural	Low-income	150	143	293
		Affluent	108	108	216
	Urban	Low-income	466	539	1005
		Affluent	514	549	1063

It is important to note that both these contextual variables are at the school-level and thus common to all students in sub-groups of the testing environment and not at the individual student level. As a result, students who attend the same school are grouped together. For example, for each student in the same school, their family income is based on the average family income of the school location. Likewise, all students who attend the same school are assumed to live in the same rural or urban location. Although these two variables are continuous, for methodological reasons we have made these two variables binary contrasting grouping variable(s). It should be further noted that because most testing programs do not collect individual level sociological / contextual variables, we anticipate that most of studies investigating the moderating effect of community variables will have to rely on linked census data and hence community-level (rather than individual) moderating variables. By using these moderating variables, we are advocating is to take a more "sociological" and "ecological" approach to help us understand differences in item and test performance.

These external reasons could be factors related to the particular testing context, such as opportunity-to-learn, facilities and resources available, socioeconomic variables, and other characteristics of the environment in which the testing, learning, and day-to-day living are taking place. To investigate the relationship between such "macro-level" and external variables, linked data was used – linking school and community-level variables with the item response strings. The complex hierarchical structure of the data where students are in classrooms, classrooms in school, and schools in districts etc. is already incorporated into our model, and thus, hierarchical linear modeling approaches are unnecessary. Contextual variables linked to item responses are

already "grouped" at the school-level. Specifically, examinees' test information was statistically linked with census data based on the school in which the examinee was enrolled.

Analyses

Scale-level Analyses

As a preliminary to the DIF modeling, the dimensionality of the numeracy items will be investigated via multi-group confirmatory factor analyses. As we described, because the domain-level scores are the primary focus of interpretation, the analyses will be conducted at the test domain level for each grade. Hence, the DIF analyses will be referred to as "differential domain functioning" (DDF) for the remainder of the paper. General linear statistical modeling will be used to investigate the moderated DDF effects of family income and of the community location (rural versus urban).

Scale-level Analyses: Factor Analysis Models

The FSA numeracy component was hypothesized to be unidimensional because the item scores are summated to form a single score to measure numeracy ability.

A simultaneous multi-group (by gender) maximum likelihood confirmatory factor analysis of a Pearson covariance matrix was conducted using LISREL 8.53 (Jöreskog & Sörbom, 2002). The Pearson matrix is appropriate because the observed variables are continuous. Table 3 shows the results of the Chi-squared difference tests for full invariance models compared to the baseline models. The full invariance hypothesis tests equality of loadings and the equality of uniquenesses between genders. The full invariance model test was repeated for community group within each grade, and thus the full invariance model tests were conducted at an α=.01, a Bonferroni-corrected α for the five model tests within each grade. The full invariance models between genders are rejected by the data for grade four overall and for grade ten rural affluent. Therefore, strong invariance models (i.e., only equality of loadings across genders) were assessed for the two rejected full invariance models. In both cases, the strong invariance model was not rejected by the data: Grade four overall $\triangle\chi^2$ (4)=7.73, p=.102, Grade ten rural affluent $\triangle\chi^2$ (4)=8.59, p=.072, and therefore strong invariance holds in those cases where full invariance does not.

Table 3. Simultaneous tests for full invariance model of Numeracy between genders overall and among contrast groups.

	Group		Full Invariance		
			$\Delta\chi^2$	Δdf	*P*
Grade 4	**Overall**		20.90	8	**0.007**
	Rural	Affluent	4.53	8	0.806
		Low Income	8.14	8	0.420
	Urban	Affluent	14.11	8	0.079
		Low Income	12.46	8	0.132
Grade 7	**Overall**		14.74	8	0.064
	Rural	Affluent	12.89	8	0.116
		Low Income	8.84	8	0.356
	Urban	Affluent	15.33	8	0.053
		Low Income	8.65	8	0.373
Grade 10	**Overall**		16.49	8	0.036
	Rural	Affluent	20.90	8	**0.007**
		Low Income	7.72	8	0.461
	Urban	Affluent	13.22	8	0.105
		Low Income	13.95	8	0.083

Note: P-values in bold are statistically significant.

Item-level Analyses: Differential Domain Functioning Results

Table 4 lists the results of the DDF analyses for each domain and grade. Table 5 lists the results of the more complex model, moderated DDF, taking into account the community location and income level of families within the community. Upon comparing Tables 4 and 5 one sees the following:

1. From Table 4, small (measured by the effect size) DDF effects are found for some domains and in some grades. For example, there is both small uniform and non-uniform DDF for the number domain in grade four. However, this DDF is not apparent in grade ten.
2. Likewise, from Table 5, small DDF effects are apparent in some community groups across domains within grades. For example, there is a small uniform DDF for the number domain within rural low-income communities.
3. Comparing Tables 4 and 5, it is evident that the DDF found in Table 4 is not the same when one takes into account the community characteristics – i.e., the moderated DDF. For example, the DDF found in the number domain for grade four students is only apparent for rural low-income communities. Likewise, the number DDF found in Table 4 for grade seven students is not at all present in the moderated case in Table 5.

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Table 4. P-values and, where appropriate, effects sizes for gender DDF effects.

		Domain			
		Number	**Patterns and Relations**	**Shape and Space**	**Statistics and Probability**
	Uniform DDF	**.002** η^2**=.002**	.111	.256	.902
	Non-uniform DDF	**.004** η^2**=.002**	.149	.308	.881
	Uniform DDF	**.003** η^2**=.002**	.314	.939	**.0001** η^2**=.010**
	Non-uniform DDF	.046	.468	.259	.009
	Uniform DDF	.401	**.0001** η^2**=.010**	.697	**.003** η^2**=.003**
	Non-uniform DDF	.756	.011	.749	.627

Note: The per DDF tests were conducted at an α=.0063; a Bonferroni-corrected α for the 8 DDF tests per grade.

Table 5. P-values and, where appropriate, effect sizes for moderated gender DDF effects by contrast group.

	Domain	Rural				Urban			
		Affluent		Low-Income		Affluent		Low-Income	
		Uniform DDF	Non-Uniform DDF	Uniform DDF	Non-Uniform DDF	Uniform DDF	Non-uniform DDF	Uniform DDF	Non-uniform DDF
Grade 4	Number	.302	.474	**.003 η^2=.021**	.008	.473	.219	.192	.604
	Patterns and Relationships	.943	.966	.615	.961	.533	.495	.166	.248
	Shape and Space	.178	.173	.374	.447	.499	.530	149	.076
	Statistics and Probability	.547	.777	.644	.591	.015	.049	.331	.712
Grade 7	Number	.257	.365	.024	.065	.011	.094	.210	.344
	Patterns and Relationships	.482	.609	.482	.459	.536	.389	.480	.971
	Shape and Space	.013	.039	.586	816	.185	.188	.122	.097
	Statistics and Probability	.064	.087	.178	.220	.087	.163	.040	.661
Grade 10	Number	.367	.554	.977	.999	.076	.364	.898	.396
	Patterns and Relationships	**.002 η^2=.046**	.023	.531	.467	**.000 η^2=.019**	**.005 η^2=.007**	.070	.565
	Shape and Space	.384	.705	.228	.568	.857	.807	.868	.710
	Statistics and Probability	.024	.062	.832	.116	.01	.630	.266	.294

Note: The per DDF tests were conducted at an α=.0063; a Bonferroni-corrected α for the 8 DDF tests per community group, per grade.

Discussion

The purpose of this paper is to introduce and demonstrate a new methodology for item and test bias studies: Moderated DIF (or in our case, moderated DDF). This "moderation" approach allows one to investigate the effect of sociological, community-based contextual, variables that may help one understand the complex functioning of DIF in large-scale testing. Conventional DIF methodology either (a) ignores all other factors than the DIF variable, (b) focuses on cognitive variables, variables that characterize the person, or (c) focuses variables that characterize the item or task such as item format, item content, or item context within the test. We are suggesting that measurement specialists should broaden their view on what effects test performance to include characteristics of the situation in which the person is learning and/or taking the test.

From our case study, it is evident that if one ignores the rural or urban community location or income level one does not get the whole picture of gender DDF. We went beyond the conventional explanatory variables for DIF and considered that in British Columbia, where the

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FSA is conducted, there are large socio-geographic differences in the province. A majority of the population lives in large urban (or geographically close to urban) communities; however, a substantial number of individuals live in rural settings. Likewise, the urban/rural split brings with it differences in wealth, both personal wealth and community economic well-being. In short, the socio-geographic features are related to variables that impact on education and opportunities to learn. Furthermore, the geography of British Columbia is such that the individuals who live in rural communities are also less well educated with lower participation rates in post-secondary education.

In the end, moderated DDF will only be of value if one works in collaboration with educational sociologists and educational economists (who are familiar with contextual community variables) to help understand why the community contextual variables are moderating the DDF.

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Appendix 1. Table of Specifications for the FSA 2000 Numeracy Component

	Content Areas	Table of Specification Percentage	# of marks	% of test
Grade 4	**Number** • Students apply their number sense to solve problems using whole numbers from 0 to 10 000 and proper fractions. • They use the basic arithmetic operations in whole number contexts.	35 – 45%	19	39
	Patterns and Relationships • Students investigate, establish and present rules for numerical and non-numerical patterns.	15 - 25%	8	17
	Shape and Space • Students estimate, measure and compare quantities using decimal numbers and standard units of measure. • They describe, classify and relate three-dimensional objects and two-dimensional shapes. • They use numbers and directional words to describe the relative positions of objects.	20 - 30%	12	25
	Statistics and Probability • Students collect, assess, validate and graph data. • They conduct simple probability experiments to explain outcomes.	10 - 20%	9	19
Grade 7	**Number** • Students solve problems involving numbers including decimal fractions and integers. • They use ratios, rates, percentages and decimal numbers in various contexts.	35 – 45%	20	41
	Patterns and Relationships • Students use expressions containing variables to make predictions. • They use variables and equations to express and summarize relationships.	15 – 25%	9	19
	Shape and Space • Students solve problems involving the properties of circles and their relationships to angles and time zones. • They link angle measurements to the properties of parallel lines. • They analyze patterns and designs using congruence, symmetry, translation, rotation and reflection.	20 – 30%	11	23
	Statistics and Probability • Students analyze data using measures of variability and central tendency. • They solve problems using probability.	10 - 20%	8	17
Grade 10	**Number** • Students solve problems involving numbers, including rational and irrational numbers. • They perform basic operations on the real number system and apply these skills in various practical, real-life or technical contexts.	25 – 35%	16	33
	Patterns and Relationships • Students use patterns to solve problems. • They simplify and manipulate algebraic expressions and make connections between algebraic and graphical representations.	20 – 30%	13	27
	Shape and Space • Students use trigonometry to analyze real-life situations. • They use geometry to analyze interrelationships among shapes.	25 – 35%	12	25
	Statistics and Probability • Students interpret, draw inferences and communicate statistical information. • They use probability terminology and determine permutations and combinations of possible events.	10 - 20%	7	15

Source: The British Columbia Ministry of Education (2000)

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